United States
Environmental Protection Agency
Region 10
1200 Sixth Avenue
Seattle, Washington 98101

Total Maximum Daily Load For Fecal Coliform In Lakes Hood and Spenard Anchorage, Alaska

In compliance with the provisions of the Clean Water Act, 33 U.S.C. § 1251 et seq., as amended by the Water Quality Act of 1987,P.L. 100-4, the Environmental Protection Agency is hereby establishing a Total Maximum Daily Load (TMDL) that would reduce the presence of fecal coliform in Lakes Hood and Spenard to comply with the beneficial use of this water body.

This TMDL shall become effective immediately. Subsequent actions must be consistent with this TMDL.

Signed this 30th day of Sep., 1997.

Philip G. Millam for
Office of Water, Director

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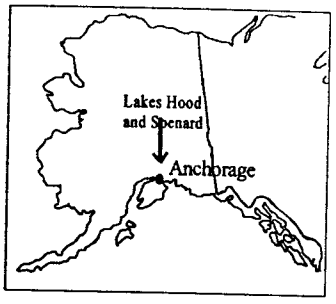
Lakes Hood and Spenard

TMDL AT A GLANCE

Water Quality Limited:	Yes
Segment Identifier:	2040-412
Parameter of Concern:	Fecal Coliform
Use(s) Affected:	Water Supply
Source(s):	Runoff from Anchorage International Airport, Lk., Spenard Park
Loading Capcaity	4.16×10^{13} FCU/day
Load Allocation:	18 FC/100mL
Wasteload Allocation:	18 FC /100mL
Margin of Safety:	2 FC/100mL



OVERVIEW:

This Total Maximum Daily Load (TMDL), developed under Section 303(d) of the Clean Water Act, addresses both point and non-point source loading of fecal coliform to Lakes Hood and Spenard. Lakes Hood and Spenard are among several lakes scattered throughout the Anchorage bowl that are presently listed on the State of Alaska 1996 303(d) list. Designated beneficial uses for Lakes Hood and Spenard include: 1)water supply, 2)water recreation, and 3) growth and propagation of fish, shellfish, and other aquatic life. The affected beneficial use is water supply. Existing data show that the water supply standard for fecal coliform is exceeded from May through September, based on limited samples.

The primary sources of fecal coliform to Lakes Hood and Spenard, based on the available data, are runoff from public beach on the north side of the lake, where Canada geese congregate during June and July, and two of the three airport storm water outfalls that drain into Lakes Hood and Spenard. Airport servicing activitives and waterfowl are thought to cause the high concentrations found in the two outfalls. The lakes, which are part of the Anchorage International Airport, receive a large part of the runoff from the airport, and also receive heavy use as a float plane base.

This is a phased TMDL. It requires additional data to be collected to determine if the load reductions required by the TMDL lead to attainment of water quality standards, and to more accurately determine assimilative capacities and pollution allocations. The monitoring requirements are laid out in a monitoring plan and schedule. The phased approach is appropriate since the data used to determine the loading capacity and set the load and wasteload allocations are limited.

Based on existing data, the loading capacity and pollution allocations are as follows. The loading capacity for Lakes Hood and Spenard is 4.16×10^{13} FCU/day or 20 FC/100mL. The load allocation for runoff from the park is 18 FC/100mL, which requires reducing the fecal coliform counts by 77 percent. The margin of safety is ten percent of the loading capacity, or 2 FC/100mL. The wasteload allocations for outfalls NPDES-A and NPDES-C are 18 FC/100mL.

This phased TMDL calls on the Airport to supplement ongoing monitoring activities in order to determine whether airport runoff is contributing to fecal coliform levels above the water supply criterion in the lakes, to confirm that the wasteload allocations set in this TMDL are necessary to meet water supply criterion, and to determine whether the BMPs currently in place will result in meeting the water supply criterion. Future actions for Lakes Hood and Spenard should be aimed at preventing runoff potentially containing fecal coliform from entering the lakes during the spring and summer.

Part 1: BACKGROUND INFORMATION

1.a Location and History

Lakes Hood and Spenard, located in south central Alaska, lie within the property of the Anchorage International Airport on the western edge of the Municipality of Anchorage. Present population in the Anchorage Borough based on the 1990 Census is 226,338 (133.32 persons per square mile). Lakes Hood and Spenard lie within the Anchorage bowl, which comprises a broad valley bordered by the Chugach Mountain Range on the east and the waters of Turnagain Arm and Knik Arm to the southwest and northwest respectively. (See Figure 1.)

While today the lakes are essentially two bays of a single lake, originally Lakes Hood and Spenard were two separate small bog lakes. By 1940, the lakes had been joined by a runway takeoff channel, dredged, and enlarged for a float plane base. During the 1950's, additional float plane mooring slips were developed. In 1975 a second main channel was dredged and 5 smaller channels with tie-down slips were constructed further enlarging the lake to the west. Dredging of a second main channel created Gull Island (R&M, 1988). The second main channel is used as a taxi way between the lakes and access to tie-down channels.

1.b Climate

The Anchorage area is generally free from permafrost in the lowlands. In the higher elevations, isolated masses of permafrost exist. Surface winds in this zone are generally light. Land surrounding Lakes Hood and Spenard is free from permafrost. Ice covers Lakes Hood and Spenard from mid-November through early April. Weather data from Anchorage International Airport was used in characterizing seasonal variation in temperature and precipitation for Lakes Hood and Spenard. Forty-four years of climatological data exist for the Anchorage International Airport.

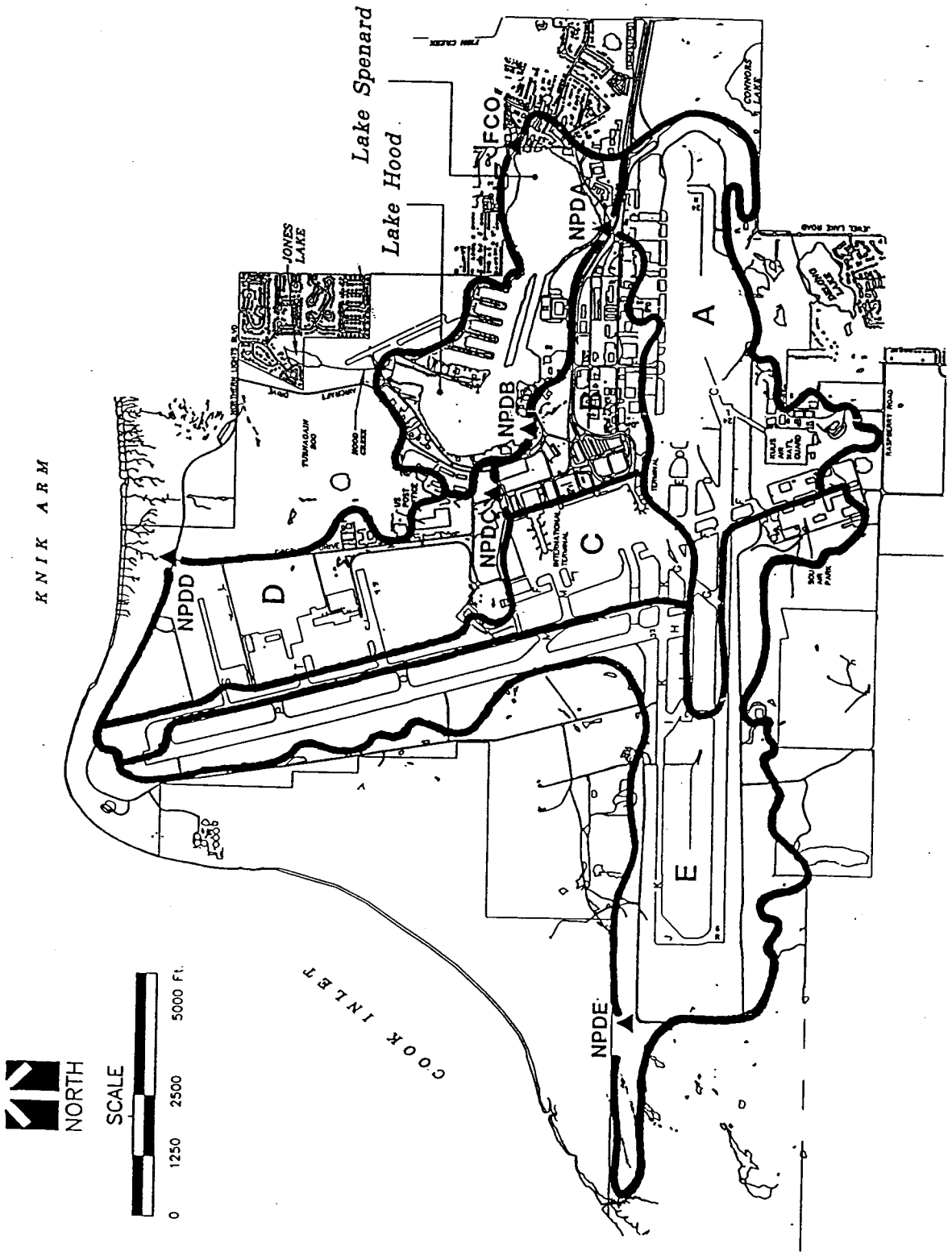
From October through Mid-April, average daily maximum mean temperatures range from 21.6°F to 40.6°F. Average daily minimum mean temperatures during this same period range from 8.2 °F to 28.5°F. The Anchorage bowl, which is dominated by snow in the winter and rain in the summer, receives an average yearly precipitation of 88.13 inches. Of that precipitation, 15.69 inches fell as rain (with rainfall lowest in spring and increasing as the summer progresses), while the remaining 72.44 inches fell as snow. (NCDC 1995)

1.c Study Area

1.c.1 Geology, Soils, and Hydrology

The geology of the watershed can be described as a sand, silt, and gravel outwash plain. A surface layer of peat, 0.5-3 m (2-10 ft) deep, extends from the lakes westward to Knik Arm (R&M, 1988). The peat depth ranges from two feet to upwards of 20 feet to the north and west of the lakes, based on construction projects over the last five years (ANC Engineering and Environmental Departments). Under this peat is a layer of sand 0-19 ft thick and below that a clayey silt layer known as the Bootlegger Cove Formation (R&M, 1988). South of the lakes, most of the peat is absent and the glacial outwash is dominant. The organic soils have low permeability. Frost depth may reach 2 m (6 ft) and may be in the ground until July.

Figure 1: Map of Lakes Hood and Spenard



Adapted from HDR Engineering, Inc. 1993a.

Total drainage area to the lakes is 517 ha (1,278 ac). Approximately 325 ha (804 ac) are impervious (HDR, 1993b). No permanently flowing streams feed the lakes, but there are three major storm water basins that discharge water from airport into the lakes. Snow melt is the greatest source of water to the lakes. Lake water flows intermittently, from the north end of Lake Hood to Jones Creek and from the east end of Lake Spenard to Fish Creek. There are weirs at both lake outlets set at about 69.1 ft.

Groundwater appears to flow from the south-southwest to the north-northeast, at a rate between 0.01 to 0.1 cubic feet per second (R&M, 1988). With assistance from the Federal Aviation Administration, the airport is building a well to pump groundwater to maintain water levels in Lakes Hood and Spenard for float plane use.

1.c.2 Animal and Plant Life

Dominant fauna in Lakes Hood and Spenard is limited to seasonal populations of waterfowl, e.g., ducks, geese, and shore birds, which are actively discouraged for reasons of safety, the occasional moose, and domestic animals accompanying recreationalists. During the summer, domestic hogs are placed on Gull Island (at the juncture of the lakes) to reduce the number of nesting birds. Presently, there is no evidence of a fishery, but it is likely that three-spine stickleback (*Gastersteus aculeatus*) and Alaska blackfish (*Dallia pectoralis*) are present in Lakes Hood & Spenard (OTT, 1990). The lakes are not stocked for fishing.

Vegetation near the lakes is limited, due in part to aircraft safety, aircraft access, and the urban setting. Vegetation immediately surrounding the lakes is limited to tall and short grasses, small shrubs and trees, and lawns. The larger airport setting is a combination of forest and sphagnum bogs. Dominant trees include black spruce, white spruce, cottonwood, willow, aspen, and birch. Sphagnum bogs in low-lying areas are dominated by black spruce and shrubs, such as bog rosemary, leatherleaf, blueberry, Labrador tea, and bog laurel (OTT, 1990).

1.c.3 Land Use

The lakes have multiple uses. They serve as the largest float plane base in North America, a storm water retention basin for airport runoff, habitat for waterfowl, and several recreational uses including a public park and beach (leased to the Municipality of Anchorage Parks and Recreation Department by the airport), a roadside park, and paths near the hotel complex at the west end of the lake. The lake is not used as a source of drinking water.

In-lake recreational use is seasonal and limited to occasional swimming and sunbathing at the public swimming beach on the north shore of Spenard Lake. Other seasonal activities include picnicking at a small roadside park near the swimming beach, bicycling, walking, and bird watching.

Adjacent to Hood Lake are runways used by numerous aircraft, as well as several offices, terminals, aircraft maintenance shops and related services, taxiways and roadways. The east end and southern shoreline of Spenard Lake and the entire shoreline of Lake Hood have been developed and are leased for use by float planes. Additional land use near Lake Spenard includes single and multiple-family residences, hotels, office buildings, and commercial air tour companies.

While the lakes are used by the public for recreation, the most intensive use of the lakes are as a landing and takeoff base and a float plane moorage facility operated by the Alaska

Department of Transportation. The float planes use the lakes year-round except during periods when the lakes are in the process of freezing or melting and when ice conditions will not support aircraft. During winter months, many aircraft are fitted with skis as landing gear and the lake ice provides an operational surface. There are two takeoff and landing lanes (one running in a north-south direction on Lake Hood and the other in an east-west orientation through both lakes and the south connecting channel) and over 700 float plane slips for mooring or parking aircraft.

The airport currently is requesting proposals for addressing drainage on airport property. The airport intends to select an option this fall and begin implementation soon thereafter. Land development proposals include new taxiways, enlarged aircraft parking aprons, support facilities, and commercial development.

Part 2: APPLICABLE WATER QUALITY STANDARDS

2.1 Designated Uses

Fresh water designated uses are established by regulation and are found in the State of Alaska Water Quality Standards (18 AAC 70 Alaska Water Quality Standards). For surface water of the state, these beneficial uses include: 1) water supply, 2) primary and secondary contact recreation 3) growth and propagation of fish, shellfish and other aquatic life. The Alaska Department of Environmental Conservation (ADEC) established freshwater designated uses found in18 AAC 70.020(a)(1). Lakes Hood and Spenard do not support their designated use for water supply in the spring and summer.

2.b Parameter of Concern

The Alaska 1996 303(d) list identified Lakes Hood and Spenard as water quality limited. due to exceedences of the fecal coliform criterion for water supply.

2.c Applicable Water Quality Criteria

Within the State of Alaska, water quality standards are published pursuant to Title 46 of the Alaska Statutes (46.03.020 and 46.03.080). Regulations dealing with water quality are found in 18 AAC 70, as noted above. Through the adoption of water quality standards, Alaska has identified the beneficial uses to be protected in each of its drainage basins and the criteria necessary to protect these uses (Table 1).

In Alaska, all waters are protected for all uses, existing and designated, and if a waterbody is protected for more than one use class, the most stringent criterion applies (18 AAC 70.030(1)). Fecal coliform criteria have been established for the protection of human health in terms of drinking water supply and contact recreation. The water supply use designation sets a fecal coliform criterion of 20 FC/100 mL.

Table 1 Alaska Water Quality Standards for Fecal Coliform

	Fecal Coliform Bacteria
(A) Water Supply (I) drinking, culinary and food processing	Based on a minimum of 5 samples taken in a 30-day period the mean may not exceed 20 FC /100 ml, and not more than 10% of the samples may exceed 40 FC/100 ml. For groundwater, the FC concentration must be less than 1 FC/100 ml, using the fecal coliform Membrane Filter Technique, or less than 3 FC/100ml using the fecal coliform most probable number (MPN) technique.
(A) Water Supply (ii) agriculture, including irrigation and stock watering	For products normally cooked and for dairy sanitation of pasteurized products, the mean, based on a minimum of 5 samples taken in a 30 day period, may not exceed 200 FC/100 ml, and not more than 10% of the sample may exceed 400 FC/100 ml. For products not normally cooked and for dairy sanitation of unpasteurized products, the criteria for drinking water (1)(A)(I) apply.
(A) Water Supply (iii) aquaculture	For products normally cooked the mean, based on a minimum of 5 samples taken in a 30 day period, may not exceed 200 FC/100 ml, and not more than 10% of the sample may exceed 400 FC/100 ml. For products not normally cooked, the criteria for drinking water (1)(A)(I) apply.
(A) Water Supply (iv) Industrial	Where worker contact is present, the mean, based upon a minimum of 5 samples taken in a 30 day period, may not exceed 200 FC/100 ml, and not more than 10% of the samples may exceed 400 FC/100 ml.
(B)Water Recreation (I) contact recreation	Based on a minimum of 5 samples taken in a 30 day period, the mean not exceed 100 FC/100 ml, and not more than one sample or more than 10% of the sample if there are more than 10 samples, may exceed 200 FC/100 ml.
(B) Water Recreation (ii) secondary recreation	Based on a minimum of 5 samples taken in a 30 day period, the mean not exceed 200 FC/100 ml, and not more 10% of the total samples may exceed 400 FC/100 ml.
(C) Growth and Propagation of Fish, Shellfish, other Aquatic Life, and Wildlife	Not applicable for freshwater.

Part 3: Pollutant Sources

3.a Non-Point Sources

The primary non-point source of fecal coliform to the lakes is runoff from the parks where Canada geese (*Branta canadensis*) congregate. To a much lesser extent, other animals, such as dogs, may contribute fecal coliform to the runoff. Animal waste enters Lakes Hood and Spenard by overland flow from Spenard Lake Park's beach and grassy areas or by defecation directly into the lake.

Since the late 1980's and early 1990's the number of Canada geese in Cook Inlet have been on the rise. Nuisance and safety problems of lesser Canadian geese in Anchorage, such as feces, lawn destruction, and hazards to traffic and aircraft, are the same as those caused by nonmigratory Canada geese that are overabundant in many lower forty-eight cities (Anchorage Waterfowl Workgroup (AWWG) White Paper, January 1997).

Cook Inlet surveys have shown that the population index had increased from about 1,500 Canada geese in the early 1980's to 5,000 geese in 1993. Anchorage counts of breeding geese increased from a few hundred in 1974 to more than 2,600 in 1996 (AWWG White Paper, January 1997). The geese population at the lakes, however, has declined since 1993, due to the Wildlife Control Program operated by the Airport and U.S. Department of Agriculture. (See Table 2 and Appendix 3.)

Two factors apparently have led to the creation of favorable habitat for Canada geese in Anchorage. Natural forested and bog habitats have been converted to abundant natural and created lakes and ponds. Also, the tall grass surrounding the these areas have been converted to lawns, and many nearby areas such as airports, parks, golf courses, and ball fields, contain lawns that provide and attractive food source for geese (AWWG White Paper, January 1997.) Grassy areas adjacent to lakes that provide landing and takeoff sites, drinking water and little harassment from dogs and humans, attract geese. Wide open grassy areas, as are typical of airports, parks, golf courses, and ball fields, also attract hungry geese whether or not water is present.

Migratory geese typically arrive in the Anchorage bowl in late May/early June. The goslings usually hatch during between the months of June and July. During the molting and brooding-rearing period in July, Canada geese shed their wing and tail feathers and are incapable of flight. Individual breeding pairs (geese usually mate for life) often use the same nesting and brood-rearing areas each year. Shortly after hatching, adults lead goslings to the nearest lake or wetlands, usually within a few city blocks. Geese are relatively stationary during the molt, but move daily from roosting and loafing areas to forage on lawns. (AWWG, White Paper January 1997.) It is during the moldting and brooding-rearing time when fecal coliform counts were at their highest. Geese begin to fly south in early August, and all but a small resident flock have left the Anchorage Bowl by mid-October.

The Anchorage International Airport and the US Department of Agriculture began a waterfowl hazing program in 1996. This consists of around-the-clock activities to discourage waterfowl from resting, nesting, or feeding at the airport from April through October. These activities likely explain the reduction in the number of Canada geese observed at Lakes Hood and Spenard.

Table 2: Waterfowl Counts on Lakes Hood and Spenard

Date of Observation	Number of Geese
June 25, 1992	610
April 12, 1993	32
April 19, 1993	64
June 23, 1993	949
July 13, 1993	898
July 27, 1993	887
August 11, 1993	13
April 19, 1996	72
July 9, 1996	231
August 21, 1996	0
April 29, 1997	0
July 7, 1997	237

The residential neighborhoods are not considered to be potential non-point sources. All the houses are on the city sewer, and a cross-connection study found a tight system. In

addition, the fecal coliform levels measured near the residential areas are not as high as would be expected from residential sources.

3.b Point Sources

Potential point sources of fecal coliform in Lakes Hood and Spenard consist of the storm water outfalls that drain runoff from three airport drainage basins (identified as A, B, and C respectively). A 1993 study (HDR Engineering, 1993a) reports that samples from drainage basins A and C have shown occasional high fecal coliform counts. Drainage basin A drains subbasins Kulis, East/West runway, and East Ramp before discharging into Lake Spenard. Drainage basin C drains the international terminal and general aviation subbasin before discharging into Lake Hood. The study suggests aircraft servicing activities as a possible source of fecal loadings. Normal ramp servicing activities for these aircraft include pumping chemical toilet effluent into service vehicles for transport and disposal (ibid).

Part 4: AVAILABLE WATER QUALITY MONITORING DATA

4.a Historical Water Quality Data

Since the mid-1980's, a variety of engineering, planning, and water quality studies were conducted by the Anchorage International Airport, the Municipality of Anchorage, and the Alaska Department of Health and Human Services (DHHS). Each of the studies that included water quality sought to characterize different aspects of water quality at a particular point and place in time. Three of these are letter reports (HDR Engineering, 1995, 1996a and b) that include data collected as a requirement of airport's NPDES storm water general permit and look at the three outfalls that empty into to Lakes Hood and Spenard. Despite the large number of reports, they contain minimal ambient data concerning the lake. The available data are marked by a wide range of variability in sampling frequency, locations, minimum detection limits and methodology. The data generally did not sample frequently enough to meet Alaska water quality standards. These reports and studies are listed in the References section.

4.b Water Quality Investigation

4.b.1 Lake Spenard Park

Fecal coliform data for Lake Spenard show exceedences of the water supply criterion during the months of May through September. (The data was provided by DHHS to EPA during the 1994 303(d) listing process.) Figure 2 portrays a normal frequency histogram plot of fecal coliform counts at two sampling locations in Lake Spenard. The precise sampling loactions are unknown, but because this data was gathered as part of the Alaska DHHS beach monitoring program, EPA believes the sampling sites were located just offshore of Spenard Lake Park, one at the east end (E) of the park beach and one at the west end (W). This plot demonstrates that most of the data lie between the water supply criterion of 20 FC/100 mL and the contact recreation criteria of 100 FC/100 mL.

Figure 3 presents the data in seasonal five-line summary plots for each sampling location. This analysis used a rolling geometric mean with a 30-day averaging period to evaluate whether Alaska water quality standards were exceeded. This analysis shows that the mean fecal coliform counts exceed the water supply criteria during the months of May through September at both sites. Figure 3(a) shows that mean fecal coliform counts at Lake Spenard

(W) increase from May to June, peaking in July, falling in August and holding constant in September. Figure 3(b) shows that mean fecal coliform counts at Lake Spenard (E) increase slightly from May to June, increasing more steeply through July to a peak in August, and decreasing slightly in September. Neither the monitoring reports nor other data indicated whether or how many migratory geese were present on the days when samples were taken, nor the weather conditions.

Figure 2 - Distribution of Fecal Coliform in Lakes Spenard (E) and (W)

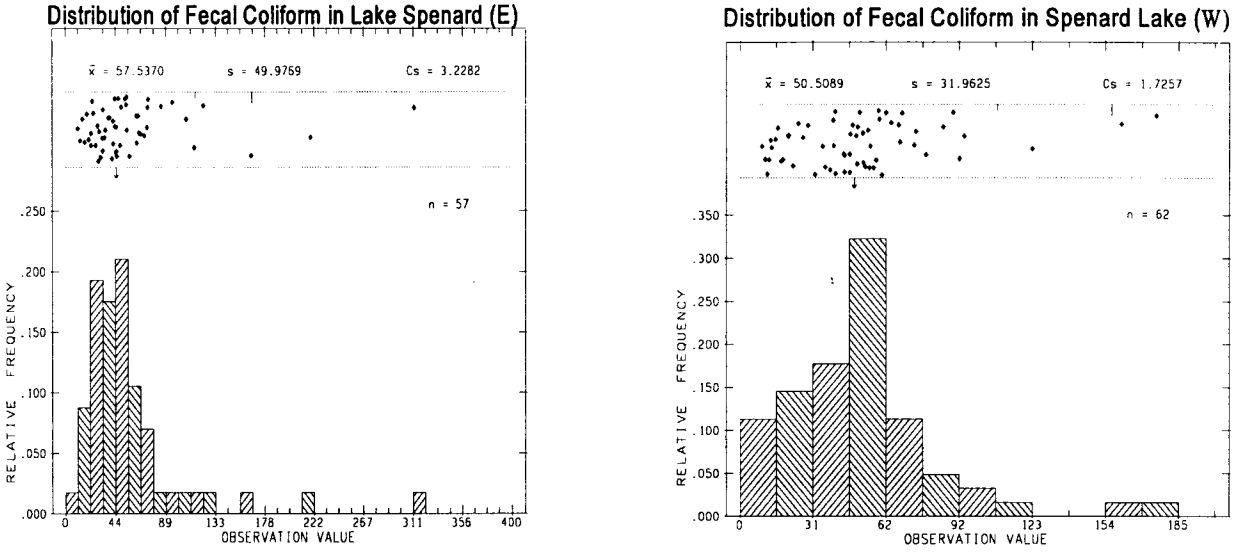


Figure 3 - Seasonal Five-Line Summary Plots of (a) Lake Spenard (E) and (b) Lake Spenard (W)

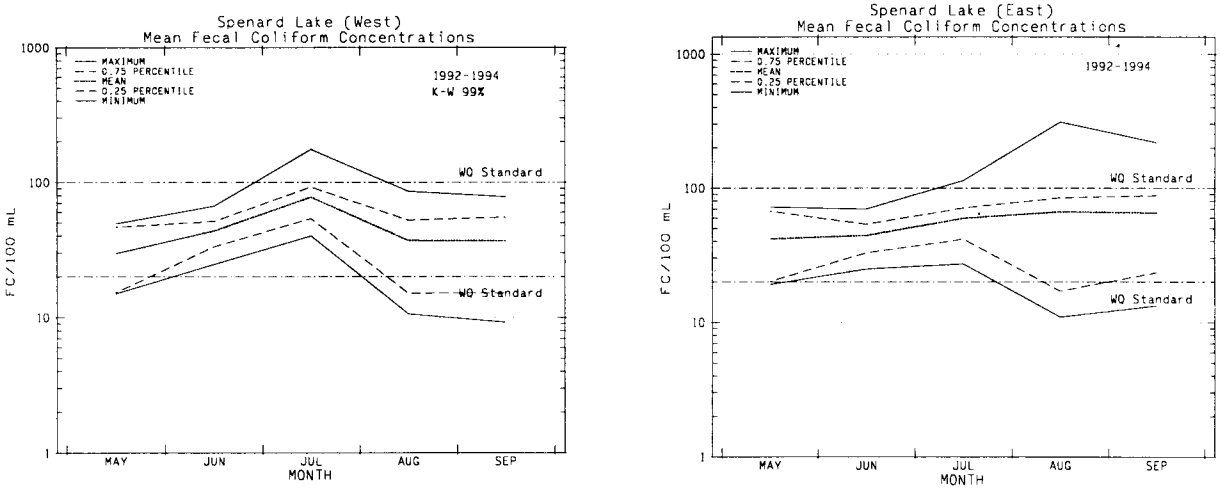


Table 3 presents the mean fecal coliform concentration for May through September. This table shows that the mean counts exceeded the water supply criterion, but met the contact and secondary criteria. The highest fecal coliform counts at Lake Spenard (W) occurred in July while the highest counts at Lake Spenard (E) occurred in August.

Table 3 - Mean Fecal Coliform Counts

Month	Lake Spenard (W)	Lake Spenard (E)
May	30	42
June	44	44
July	78	60
August	37	67
September	37	65

4.b.2 Lake Hood Investigation

Fecal coliform sampling data for Lake Hood is limited to samples collected as a part of the 1993 Anchorage International Airport Water Quality Study (HDR Engineering, 1993a). Samples from two sampling locations on Lake Hood were tested for fecal coliform and fecal streptococci. Based on the ratio of fecal coliform to fecal streptococci, fecal coliform in those samples were more likely to have animal sources than human sources. Data were inadequate to compare to water quality standards or attribute to a source.

4.b.3 Storm Water Outfall Investigation

Storm water discharges from the Anchorage International Airport also provide fecal coliform to Lakes Hood and Spenard. The 1993 Airport Water Quality Study presents 1991 data from two drainage basins, A and C, that exhibited fecal coliform counts exceeding all applicable criteria.

Drainage basin A drains the Kulis, East-West Ramp runway, and East Ramp subbasins, all of which drain to Lake Spenard. According to the Airport Water Quality Study, drainage basin A contains four water quality sampling locations, two of which (Water Quality Sampling Sites WQ8 and WQ9) exceeded the fecal coliform criteria of 20 FC/100 mL. These sampling sites lie along the same drainage pathway. Fecal coliform counts increased from 1460 FC/100 mL at WQ8 to 5900 FC/100 mL at WQ9. At that time, data was not collected from the drainage outfalls to determine the amount of fecal matter emptying into Lake Spenard. The average fecal coliform count in drainage basin A under various weather conditions was 2180 FC/100 mL, which exceeds all the fecal coliform criteria.

Drainage basin C drains the International Terminal, parts of the Main Terminal, General Aviation tiedowns, and associated roads, all of which drains to Lake Hood. This basin has the majority of all domestic and international airline passenger traffic and associated airline support services such as food, water, and waste transfers. Drainage basin C contains two water quality sampling locations, according to the 1993 Airport Water Quality Study. Both water quality sampling sites lie along the same drainage pathway. Samples from these sites, WQ16 and

WQ17, exceeded the fecal coliform criterion of 20 FC/100 mL. Fecal coliform counts increased from 100 FC/100 mL at WQ16 to 540 FC/100 mL at WQ17. At that time, data was not collected from the outfall NPDES-C to determine the amount of fecal matter potentially entering into Lake Hood. The average fecal coliform count in drainage basin C under various weather conditions was 300 FC/100 mL, which exceed all the fecal coliform criteria.

All sampling data taken in 1991 pre-date the Airport's environmental program, storm water general permit and pollution prevention plan, and waterfowl hazing program. Since then, the number of waterfowl at the Lakes has dropped by 75 percent and the Airport and its tenants now implement BMPs under their own site-specific storm water permits and storm water pollution prevention plans. Significant reduction in fecal coliform counts are likely to have been achieved, but no data is available to verify.

4.c Non-point Source Loading Analysis

EPA conducted a loading analysis to determine whether runoff containing fecal coliform bacteria from Canada geese accounts for the fecal coliform counts found in the DHHS study of public beaches. This analysis was based two previous studies conducted by Manny, Johnson, and Wetzel (1994), and Reichgott, Holdren, Martin, and Miller (1990). The analysis uses information about the loading rate for Canada geese, residence time of geese on the beach and park area, runoff rates, and the volume of water in the area adjacent to the beach to develop potential fecal coliform loadings. Table 4 displays results from this analysis. Detailed discussion of this analysis is in Appendix 1 (Technical Appendix).

Table 4

Potential Fecal Coliform Counts	
Number of Geese	Potential Fecal Coliform Counts # FC/100 mL
20	48
50	120
100	240

Based on the potential fecal coliform counts presented in Table 4, fecal coliform counts attributable to the goose population appear significantly higher than the fecal coliform levels found in the Alaska DHHS study. This indicates that the potential loading by waterfowl is offset by other factors.

Several factors, such as rainfall during the summer months, the number of geese on shore versus the number of geese on the lake, and the sampling location(s) may influence the mean fecal coliform counts and the potential counts as well. Consequently, the number of geese associated with the potential fecal coliform counts should be considered a rough estimate.

This analysis assesses only loading from Spenard Lake Park's runoff. A determination that runoff from the park is the sole non-point source of fecal coliform loading to Lakes Hood and Spenard cannot be made based on the available water quality data. This analysis does indicate, however, that runoff from the park is likely the primary source of the fecal coliform loading monitored by Alaska DHHS.

As Table 3 shows, the waterfowl population decreased 75 percent between 1994 and 1997. This indicates that current fecal coliform counts may be significantly lower than those in Table 2. A 75 percent decrease in fecal coliform counts from 1994 would yield levels close to the water supply standard.

4.d Conclusions

Based on data presented above, mean fecal coliform values exceed the water supply criterion during the spring and summer, but do not exceed the State of Alaska primary and secondary contact recreation criteria. July and August were the months when the heaviest fecal coliform counts occur in Lake Spenard. The only probable non-point sources of fecal coliform loading is runoff from Lake Spenard Park, which probably includes feces of both Canada geese and, to a much lesser degree, dogs.

Based on instantaneous samples collected from sampling sites within drainage basins A and C, an exact determination of the source of fecal coliform is unknown. Potential sources of fecal coliform include passenger servicing activities, such as pumping chemical toilet effluent into service vehicles for transport and disposal, and waterfowl. While the fecal coliform counts were high, we do not know whether they were isolated or frequent, nor do we know their effect on the lakes' water quality.

Because the population of Canada geese has decreased since 1994, when Lakes Hood and Spenard were last monitored for fecal coliform, fecal coliform counts may be significantly lower, perhaps close to the water supply criterion.

The uncertainty surrounding the role of the stormwater outfalls in contributing fecal coliform is significant, as that information is key to establishing accurate load and wasteload allocations. The available data do not contain information about flow from the outfalls, fecal coliform counts in the effluent, nor ambient (water quality) conditions in the water where the storm water effluent enters the lakes. The only fecal coliform data for storm water runoff that drains through the outfalls is old, dating from 1991, and pre-dates current activities designed to prevent pollution (e.g., waterfowl hazing, storm water BMP implementation).

Part 5: TMDL Evaluation

5.a General Approach

A total maximum daily load or TMDL is a planning and management tool to restore water quality. The TMDL document presents an analysis of the relationship between pollution sources and water quality conditions. It identifies the loading capacity and associated wasteload allocation(s) from point sources, load allocation(s) from non-point sources or background, and a margin of safety to compensate for uncertainty and future growth. As new information becomes available in the future, the TMDL may be refined. Because this is a phased TMDL, it will be revised, if necessary, after the required monitoring has been completed.

A phased TMDL is an appropriate approach when available data is used to develop the load and wasteload allocations and additional monitoring is necessary to more accurately determine assimilative capacities and confirm whether the load and wasteload allocations will provide load redutions that will attain water quality standards. This is the situation with Lakes Hood and Spenard. Because the available data is limited, the assimilative capacity and the

appropriate load and wasteload allocations will attain water quality standards cannot be finally determined without more data.

This TMDL sets a loading capacity, load and wasteload allocations with a margin of safety, and contains a monitoring plan and schedule for completing the next phase of this TMDL. This TMDL, although called "phased" and requiring subsequent actions, is a complete TMDL for the purposes of Section 303(d) of the Clean Water Act.

5.b Loading Capacity

This TMDL sets a loading capacity for Lakes Hood and Spenard that EPA believes is is protective of human health and meets the State of Alaska's water quality standards. The loading capacity is 4.16×10^{13} FCU/day. In terms of Alaska's water supply criterion, the loading capacity is 20 FC/100mL. The lakes' loading capacity will be considered again after additional data have been collected.

5.c Load Allocations

The load allocation is the portion of the loading capacity associated with non-point sources and background. The primary non-point source is runoff from the park area on the north side of Lake Spenard, where waterfowl are most likely to congregate. As explained above, EPA believes that the fecal coliform samples from Lake Spenard were taken close to the park beach. The loading analysis above demonstrates that the number of Canada geese congregating on the beach could produce enough fecal coliform to account for the sample results. This in turn indicates that the the point source contribution from the outfall had minimal impact on the samples taken near the beach. Therefore, EPA believes that runoff from the park park is the sole significant fecal coliform source for this portion of the lakes and sets the load allocation accordingly. This assumption will be revisited after additional data have been collected.

The load allocation is 18 FC/100 mL. Based on the highest mean fecal coliform count from Table 3, this requires a 77 percent reduction from the fecal coliform levels measured in 1994.

5.d Wasteload Allocation

The wasteload allocation is the portion of the loading capacity associated with point sources. Outfalls NPDES-A and NPDES-C have individual wasteload allocations of 18 FC/100mL. This level ensures compliance with the water supply criterion for fecal coliform. At this level, these outfalls' effluent will not exceed standards. While we assume that at this level the lakes will not exceed the water supply criterion, the phased TMDL approach requires monitoring to test this assumption. After gathering additional information on flow and current fecal coliform counts in the storm water outfalls and in the lakes, these wasteload allocations may be revised.

5.d Margin of Safety

For Lakes Hood and Spenard, 10 percent of the loading capacity is established as the margin of safety to acount for the uncertainties in the analysis. This translates to a margin of safety of 2 FC/100mL. This margin of safety is reasonable because expected trends in fecal coliform are more likely to be downward than upward, and the potential human health impacts are mild, temporary and avoidable.

Part 6: Current and Future Actions

6.a Current Actions

Current actions to reduce fecal coliform in Lakes Hood and Spenard include efforts by the Airport through its Wildlife Control Program; actions by the Airport and its tenants to implement good housekeeping measures from their storm water pollution prevention plans under their General Industrial Permit; captial improvement projects to install drainage, water and sewer to all areas of the airport; and efforts by the Airport and the Municipality of Anchorage through their work with the Anchorage Waterfowl Workgroup.

Airport Waterfowl Hazing Program

In 1995, the US Department of Agriculture (USDA) completed an ecological study of the airport addressing wildlife hazards to aviation safety. Currently, the USDA provides personnel to manage waterfowl on the Airport during the bird migration and nesting season. Since 1996, the Airport and USDA staff work 24 hours a day to prevent birds from resting, nesting, or feeding at the airport from April through October. To date, waterfowl numbers are less than one-third of their peak numbers four years ago. The Airport reports over 87,000 bird hazing incidents in 1996 (Plumb, Letter of 9/24/97, page 4). See Appendix 3.

Storm Water General Permit for the Airport

The Anchorage International Airport and its regulated tenants are covered by industrial general permits for storm water, which are based on BMPs to ensure compliance with water quality standards. Consistent with the objectives of storm water regulations to reduce or eliminate the number of pollutants and amount of pollution in storm water, eliminate illegal dumping and eliminate illicit connections, the Airport's NPDES Storm Water Pollution Prevention Plan includes a wide variety of BMPs oriented toward these objectives.

Anchorage Waterfowl Workgroup

In early 1996, the Anchorage Waterfowl Working Group (AWWG) was formed to devise solutions to deal with increased migratory bird population in the Anchorage bowl. The AWWG is composed of representatives of the Alaska Department of Fish and Game (ADF&G), U.S. Fish and Wildlife Service (USFWS), Municipality of Anchorage Department of Health and Human Services (DHHS), Cultural and Recreational Services, Merrill Field, and Loussac Library; U.S Department of Agricultural - Animal Control Division (ADC); Federal Aviation Administration (FAA); Elmendorf Air Force Base (EAFB); Fort Richardson Army Post; Alaska Department of Transportation and Public Facilities-Anchorage International Airport (AIA); Anchorage Audubon Society; and the National Wildlife Federation.

The AWWG is moving forward to complete the following: 1) to inform Anchorage citizens, agencies and businesses of the problems and benefits associated with urban Canada geese; 2) to provide a forum for exchange of ideas and information between the community and responsible government agencies; 3) to educate the Anchorage community on health and safety problems, both to people and waterfowl, that result from feeding waterfowl in Anchorage; and 4) develop a responsible, practical and effective plan for cooperative management of waterfowl and their habitat in Anchorage.

While Lakes Hood and Spenard is not the primary focus of the AWWG, their educational and management activities will be relevant to Lakes Hood and Spenard. These measures will enhance the Airports efforts to reduce the number of geese attracted to the lakes, thereby further reducing fecal coliform levels in the lake.

Some specific actions that have been taken or are being considered to reduce non-point source loading of fecal coliform in Lakes Hood and Spenard include prohibiting the feeding of waterfowl, replacing short grass on the beaches and elsewhere with tall grass, and adding landscape features to minimize or delay runoff from entering the lakes.

6.b Future Actions

This phased TMDL calls upon the Anchorage International Airport to conduct a monitoring program to determine the assimilative capacity of Lakes Hood and Spenard, to confirm whether the wasteload allocations will lead to attainment of water quality standards, and whether the current BMPs are adequate to meet water quality standards. Information on flow, lake volume, and water quality in the drainage basins, the outfalls, and the receiving waters is necessary to answer these questions and may be used to revise the loading capacity, load and wasteload allocations and BMPs. A water quality monitoring plan for Lakes Hood and Spenard, designed to meet these objectives, is outlined in Appendix 2.

EPA will work with the Airport to refine the sampling program and schedule, and would welcome the participation of ADEC, the Municipality of Anchorage, and DHHS who all have an interest in water quality at the lakes. The final sampling plan will be complete approximately April 1, 1998. Sampling for fecal coliform, flow, and lake volume should begin with spring melt in April, 1998, and continue until the lake freezes, approximately in October. A report summarizing the data should be completed within three months, in January 1999. EPA will then revise this TMDL if necessary.

Meanwhile, in order to maintain coverage under the general permit, the Airport's BMPs must ensure compliance with Alaska's water quality standards. With the TMDL in place, the wasteload allocation becomes the target for the outfalls' water quality. Therefore, the Airport will need to work with its tenants to revisit their BMPs and revise them as needed to ensure compliance with the wasteload allocations. Should implementation of effective BMPs prove inadequte, EPA will consider other actions including permit modification, reissuance of the storm water permit, and enforcement.

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Appendix 1
Technical Appendix
Loading Analysis for Fecal Coliform from Spenard Lake Park

To estimate the potential contribution of fecal coliform bacteria into Lake Spenard from Spenard Lake Park, a loading analysis was conducted. Information in the this analysis was based two previous studies conducted by B.A. Manny, W.C Johnson, R.G. Wetzel (1994) and Christine B. Reichgott, G. Chris Holdren, Michael R. Martin, and Marlene R. Miller (1990). In this loading analysis several assumptions were made based on available data, previous studies, and knowledge of the area.

Concept

The general concept for the lakes Hood and Spenard TMDL is that once fecal matter is deposited on the grass and/or gravel by Canada geese in Spenard Lake Park, rainfall will wash much of the bacteria into the lake.

Assumptions

- Canada geese remain on the grassy area in the park for an average of six hours a day during the molting and brooding season. (Reichgott et al., 1990)
- Fecal matter from geese in Spenard Lake Park builds up in the grassy area park.
- Ten percent of the deposited fecal matter is washed into a section of the lake adjacent to the park beach (the estimated impact area). (Reichgott et al., 1990)
- The estimated impact area is approximately 262 ft. long (the length of the beach), 100 ft wide (the assumed impact distance offshore), and 3 ft deep (the mean depth of this area). (Personal communication, Patrick-Riley, 1997).
- The area affected has a volume of 2.23×10^9 mL The area effected is 26,200 sq ft (Ibid.)
- The runoff of fecal matter from the beach is an episodic load, with bacteria introduced within the first hours of a daily storm event.
- Runoff completely mixes within the estimated impact area.
- Bacteria does not build up over time due to a combination of dilution with surrounding lake water and bacterial die-off.

Limitations

This loading analysis acknowledges several limitations:

- Available water quality data did not specify:
  1) The number of geese present during the time of sampling (onshore and on the lake);
  2) The climatic conditions at time of sampling
  3) Sampling locations near the beach (i.e approximate distance offshore and depth where samples were taken);
- The number of fecal coliform samples taken during the summer months was less than the State of Alaska water quality criteria of 5 samples in a 30-day period.
- Data was not available to determine a site specific die-off rate for bacteria suspended in Spenard Lake.
- Direct defection from Canada geese into Lake Spenard was not factored into the analysis, because the average on-lake time for Canada geese is unknown.

- The actual amount of fecal matter washed into Lake Spenard is unknown.
- Nutrient content in Lake Spenard is unknown.
- Fecal coliform input from dogs or other animals is not factored into in the analysis due to the lack of data.
- No data was available to evaluate possible fecal coliform inputs from the snow dumps.
- No data was available to evaluate possible fecal coliform inputs from Gull Island or other non point-sources.

In computing possible fecal coliform counts, the equation below was used. This equation factors in the loading rate from geese, time geese spend at the park, and percent that runs off the park and beach, and divides these factors by the lake volume. The final product results in a loading coefficient ($L_{(Coefficient)}$).

Loading Coefficient Equation

$$L_{(Coefficient)} = LR*T*PR/\ V(fraction)$$

LR Loading Rate for Canada Geese = loading rate of geese x average weight of geese dropping x defecation rate = 11.06 x 10^7 fc/g x .714 g x 28 days), where fc= fecal coliform colonies and g=grams (Ray B. Owen.Jr) (Manny et al., 1994).

T Number of hours on beach = 6 hours = .25 days (Reichgott et al., 1990)

PR Percent Runoff = .10 (Reichgott et al, 1990)

V Volume of water in area = Length X Width X Depth = 262 ft. x 100 ft. x 3 ft. =78,600 cu. ft. = 2.22 X 10^9 mL (Personal communication, Patrick-Riley, 1997).

The $L_{(Coefficient)}$ is multiplied by the number of geese present to derive a possible bacterial count due to geese. The result is expressed in FC/100 mL and is presented in the table below.

Potential Fecal Coliform Counts

Number of Geese	$L_{(Coefficient)}$	Potential Fecal Coliform Counts # FC/100 mL per day
20	2.48	50
30	2.48	74
40	2.48	99
50	2.48	124
60	2.48	149
70	2.48	174
80	2.48	198
90	2.48	223

The analysis indicates that potentially under ten geese could potentially produce sufficient fecal coliform to meet or exceed the water supply criterion of 20 FC/100 mL, and potentially 40

geese could produce approximately 100 FC/100 mL. Due to the assumptions used by this analysis, these numbers should be considered rough estimates.

Appendix 2
Monitoring Plan and Schedule
for Lakes Hood and Spenard
Phased Total Maximum Daily Load (TMDL)

Project Overview

The Lakes Hood and Spenard (the lakes) phased TMDL monitoring plan has been developed to address two main goals. The first goal is to set up a series of field sampling sites to evaluate fecal coliform concentrations throughout the lakes and to gather information about flows out of the lakes into Hood Creek and Fish Creek. The second goal is to evaluate fecal coliform discharged from stormwater outfalls, beaches and snow dumps to Lakes Hood and Spenard during spring snow melt, and in dry and wet weather conditions. In addition to sampling the stormwater outfalls at the point of discharge, "upstream" sampling may assist in determining how to best reduce fecal coliform concentration. Monitoring should commence in April 1998, and continue though October 1998.

Objectives and Intended Use of Data

The objective of the monitoring plan for the Lakes is to obtain sufficient fecal coliform data from all basins and of the concentrations and extent of fecal coliform in the lakes to determine if the stormwater from the Anchorage International Airport contributes to the exceedence of State of Alaska water quality for fecal coliform. This data will then be used to calculate, if necessary the loading capacity of the lakes and to determine source loadings from the stormwater outfalls and to recalculate the wasteload allocation, if necesssary the wasteload allocation for these sources. This data may also be useful to assist in selecting and evaluating best management practices (BMPs).

Monitoring Approach

In order to determine fecal coliform contributions from the all stormwater outfalls draining from the Anchorage International Airport and Spenard Lake Park adequately, the following sampling protocol should be used.

1. Sample from the lakes as well as source areas should occur between the months of April and October (Inclusive, unless discharge is occurring because of freezing conditions).

2. During sampling, the presence, location, and number of animals and the presence, location and type of human activities should be recorded.

3. All fecal coliform samples collected should be consistent with the State of Alaska Water Quality Standard for bacteria (five samples within a 30 day period).

4. During the spring snowmelt, weekly fecal coliform samples should be taken from the runoff from the snowdumps around the Lakes.

5. Storm event sampling should occur at least once a month.

6. The lake levels or other measures of the volume should be taken monthly.

7. Flow rates of the two creeks should be measured and recorded monthly (and during and after significant precipitations).

8. Sampling locations for snowmelt, routine and storm event sampling should be consistent thought out the year and must be representative of the discharge to the lakes. Instantaneous flows, if applicable, should be measured each time fecal coliform samples are taken.

9. Fecal coliform monitoring sites shall include sites near Gull Island, all stormwater outfalls, weir near outlets for Hood Creek and Fish Creek, the public beach, and the middle of the lakes.